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ORIGINAL ARTICLE

Reversal of the hip fracture secular trend is related to a decrease in the incidence in institution-dwelling elderly women

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Abstract
Summary In this prospective 10-year study in elderly aged 60 years and over, there was a 1.3% per year reduction in the standardized incidence of hip fracture in women but not in men. This decrease was mainly due to changes in the standardized incidence of hip fracture in institution-dwelling women.
Introduction A decrease in age-adjusted hip fracture incidence has been recently demonstrated in some countries. Since a large proportion of hip fractures occur in nursing homes, we analyzed whether this decreasing trend would be more detectable in institution-dwelling elderly compared with community-dwelling elderly.
Methods All hip fracture patients aged 60 years and over were identified in a well-defined area. Incidence of hip fracture, age- and sex-adjusted to the 2000 Geneva population, was computed in community- and institution-dwelling elderly.
Results From 1991 to 2000, 1,624 (41%) hip fractures were recorded in institutionalized-dwelling elderly and 2,327 (59%) in community-dwelling elderly. The standardized fracture incidence decreased by 1.3% per year in women (p=0.039), but remained unchanged in men (+0.5%; p=0.686). Among institution-dwelling women, hip fracture incidence fell by 1.9% per year (p=0.044), whereas it remained stable among community-dwelling women (+0.0%, p=0.978). In men, no significant change in hip fracture incidence occurred among institution- or community-dwelling elderly.
Conclusions The decrease in the standardized hip fracture incidence in institution-dwelling women is responsible for the reversal in secular trend. Future research should include stratification according to the residential status to better identify the causes responsible for the trend in hip fracture incidence.

Keywords Epidemiology · Hip fracture · Incidence · Nursing homes · Prevention · Secular trend

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Introduction

Hip fractures are a large burden to older patients and their caregivers, and represent one of the most important causes of physical disability, social dependence, and death among the elderly [1, 2]. Thus, it is important to reliably

estimate the present and likely future incidence of hip fracture to help project the costs and resources needed to manage the problem. The risk of hip fracture is particularly high for those living in nursing homes compared with those living in private homes [3–7], possibly in relation to their greater age and the higher prevalence of physical and mental impairments.

During the past decade, hip fracture incidence has reached a plateau [8–12] or has even declined in some countries [13–16]. In the State of Geneva, where about 40% of hip fractures occur in nursing homes [17], we observed a significant decrease in the standardized incidence of hip fractures in women, but not in men, despite an increase in the mean age of women with hip fractures [18]. At the same time, prevention strategies against osteoporosis and fractures (e.g., hormone replacement therapy, nutrition, physical activity, and fall prevention), as well as treatments for osteoporosis (e.g. bisphosphonates), were increasingly used over this 10-year period [19–24]. Therefore, we asked the question: would the changes in hip fracture incidence observed over the last decade in the State of Geneva be more detectable in an institution- or in a community-dwelling elderly population.

Materials and methods

Participants

The State of Geneva (Switzerland) has a population of about 400,000 people, of whom 19% are aged 60 years or over. Of this population, 4.6% are living in nursing homes. The State of Geneva has one of the longest life expectancies in Switzerland (84.0 for women, 78.2 for men in 2000) [25], a country that already has a very high life expectancy. Nearly all hip fractures (93.4%) occurring in the State of Geneva resulted in hospitalization at the Geneva University Hospital [26]. It assured a homogeneous record of all cases of hip fractures analyzed in the present study. We utilized the database of the Geneva University Hospital to identify patients aged 60 and over discharged with a diagnosis of a hip fracture (ICD-10 code: S72.0 and S72.1) between January 1991 and December 2000. All diagnoses made before 1996 were originally coded using the ICD-9 WHO classification, but automatically recoded to the ICD-10 in 1996. Patients living outside the State of Geneva and patients with pathological fractures or late complications of fractures of the proximal femur requiring a second intervention were excluded from the study. On these grounds, 3,951 cases of hip fracture were selected. The database included the patient's date of birth, date of hospitalization, gender, address, and postcode at the time of the fracture. We determined whether the patient's postal address corresponded to an institution or to a private home (assisted living apartments included) by using an address-based register of all nursing homes in the State of Geneva.

Analysis

Hip fracture incidence (number of hip fractures per 100,000 person-years of risk) was computed as a function of gender, 5-year age groups (from 60 years to 90+ years), calendar year (from 1991 to 2000), and residential settings (community-based and nursing homes). We used the age and gender profile of people aged 60 and over in each residential setting as the denominator for calculation of fracture incidence. Population profiles in adults aged 60 and over living in nursing homes were provided from 1992 to 2000 by a survey managed by the General Direction of Social Services, State of Geneva. Before 1997, 75–97% of the nursing homes responded to the survey and 100% responded after 1997. As previously done by Brennan et al. [3], we estimated the population profile for nonrespondent nursing homes by extrapolating from figures observed in responding nursing homes. In other words, we hypothesized that the gender and age distribution of residents in responding nursing homes was representative of gender and age distribution of the whole population of nursing home residents in the State of Geneva. In 1991, only the total number of residents in nursing homes was known and the gender and age distribution of residents of this year was assumed to be the same as the distribution observed in 1992. The population profile for community-dwelling people was calculated by subtracting the number of nursing home residents from the census population estimates supplied by the local State Statistical Office. To adjust for the aging of the population over the 10-year period, a direct method of standardization was used [27]. After standardization for the population of Geneva in 2000, any differences between hip fracture incidences among the 10 years cannot be attributed to different age and sex distribution, but must be attributed to some other factors.

The present study employed the same statistical analyses as in our previous works on hip fracture incidence in the State of Geneva [17, 18]. Logistic regression analyses, including year and age classes, were performed for both genders and residential settings to assess whether the secular change in fracture incidence depended of the residential settings of elderly people. Evolution of the mean age of women and men with hip fractures, residing in the community or in an institution, was analyzed using analysis of variance. P values less than 0.05 were considered to be significant. Statistical analyses and confidence intervals were computed using the "blogit" and "anova" commands of Stata statistical software version 7 (College Station, TX, USA).

Results

Overall characteristics

Over the 10-year period (1991–2000), 3,185 (80.6%) hip fractures were recorded in women and 766 (19.4%) in men. The age- and gender-specific incidence of hip fracture rose steeply with advancing age (Fig. 1). Hip fractures occurred later in women than in men (83.7±8.0 years ±SD vs 81.0± 8.9; $p<0.001$) and its incidence, standardized to the 2000 Geneva population, was higher in women than in men (701 [95% CI: 677–725] per 100,000 person-years vs 248 [95% CI: 231–265]; $p<0.001$; Table 1). Over the study period, 1,624 (41%) hip fractures were recorded in institution-dwelling elderly and 2,327 (59%) in community-dwelling elderly. Whatever the gender, patients with hip fractures residing in nursing homes were significantly older than those residing in the community (86.4±6.5 vs 81.6.±8.5 years [$p<0.001$] in women and 84.5±7.9 vs 79.7±8.9 years [$p<0.001$] in men). For both women and men, standardized fracture incidence was higher in institution-dwelling elderly than in community-dwelling elderly (5,245 [95% CI: 4,975–5,515] vs 431 [95% CI: 412–450; $p<0.001$] in women and 3,442 [95% CI: 2,996–3,888] vs 185 [95% CI: 170–200; $p<0.001$] in men; Tables 2, 3).

Changes over 10 years

Over the 10-year period, the mean age of patients with hip fractures increased by +0.13 year per year (95% CI 0.01–0.25; $p=0.032$) and by +0.14 year per year (95% CI 0.01–0.27; $p=0.038$), in institution-dwelling and community-dwelling elderly women respectively (Fig. 2). In men of the corresponding groups, change in mean age was not significant (+0.28 per year, 95% CI −0.08–0.65; $p=0.129$ and −0.07 per year, 95% CI −0.32–0.19; $p=0.609$ respectively). The incidence of hip fractures, standardized to the 2000 Geneva population, significantly decreased by 1.3% per year (95% CI: −2.4 to −0.1) in women ($p=0.039$) and remained unchanged (+0.5% [95% CI: −1.9 to 2.9]) in men ($p=0.686$; Fig. 2). This decrease in women was mainly due to changes in the standardized incidence of hip fracture in institution-dwelling women. Among this population, the number of hip fractures did indeed decline over the study period from 162 to 129 (Table 2). In parallel, the population at risk in nursing homes remained stable, so that the age- and sex-adjusted (to GE 2000) incidence actually fell from 6,197 per 100,000 in 1991, to 4,934 per 100,000 in 2000. More specifically, the standardized incidence of hip fracture in institution-dwelling women has fallen over the 10-year period by 1.9% per year (95% CI: −3.8 to −0.1; $p=0.044$; Fig. 2). By contrast, annual fracture incidence in community-dwelling women remained stable (+ 0.0% [95% CI: −1.6 to 1.6; $p=0.978$]). Figure 2 also indicates that no significant change occurred among elderly men living in nursing homes (+1.0% [95% CI: −3.7 to 5.7; $p=0.666$]) or in a private home (+0.8% [95% CI: −2.0 to 3.6; $p=0.565$]). The overall female/male hip fracture incidence ratio was 1.53 (95% CI: 1.28–1.85) in institutional-dwelling elderly and 2.32 (95% CI: 2.05–2.65) in community-dwelling elderly. Only the former significantly decreased by 0.05 (95% CI: −0.08 to −0.01) per year ($p=0.014$).

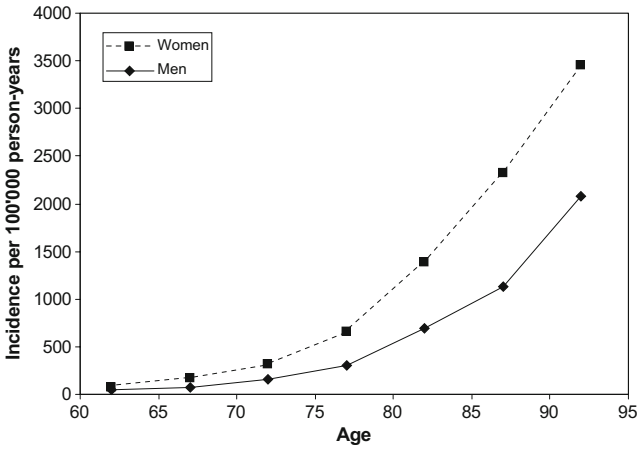

Fig. 1 Age- and gender-specific incidence of hip fractures

Discussion

In this prospective 10-year study in men and women aged 60 years and over, there was a 1.3% per year reduction in the standardized incidence of hip fractures in women, but not in men. The decrease in the standardized hip fracture incidence in institution-dwelling women fully accounted for this change. Indeed, among institution-dwelling women, the annual hip fracture incidence has fallen by 1.9% per year. By contrast, annual hip fracture incidence in community-dwelling women remained stable. In men, no significant change occurred among those living in private homes or in nursing homes. Although several studies reported an increase in hip fracture incidence [28–31], the reduction in hip fracture incidence evidenced in the present paper is consistent with some recent reports showing that hip fracture incidence has reached a plateau [8–12] or has even declined in some countries [13–16].

A first strength of this study is that virtually all hip fractures that occurred within the State of Geneva were treated in a single hospital ensuring a homogeneous record of all cases of hip fractures [18, 26]. Thus, the number and incidence of hip fractures were not cohort-based, but corresponded to a complete population results. Second, to our knowledge, this is the first report to assess the trend in hip fracture incidence separately in institution- and community-

Table 1 Number of hip fractures (*NF*), person-years at risk (*N60+*), mean age at hip fracture (*Age*), incidence of hip fracture in women and men (≥ 60 years) per 100,000 person-years, expressed without (*Inc*) and after standardization to the 2000 Geneva population (*IncGE*), over a 10-year period (1991 to 2000)

	Women					Men				
Year	NF	N60+	Age	Inc	IncGE	NF	N60+	Age	Inc	IncGE
1991	351	42,626	83.2	823	847	72	28,291	80.6	255	257
1992	317	43,063	83.5	736	743	78	28,813	80.9	271	271
1993	326	43,547	83.4	749	753	64	29,222	80.4	219	224
1994	302	43,981	83.6	687	682	70	29,805	81.8	235	240
1995	273	44,292	83.9	616	609	73	30,376	81.2	240	241
1996	316	44,573	83.2	709	704	70	30,949	81.3	226	228
1997	319	44,881	84.5	711	710	87	31,454	81.2	277	280
1998	328	45,368	83.7	723	728	75	32,021	82.4	234	239
1999	318	45,948	84.0	692	693	91	32,588	79.6	279	280
2000	335	46,648	84.3	718	718	86	33,355	81.2	258	258
1991–2000	3,185	444,927	83.7	716	701	766	306,874	81.0*	250*	248*

*Significant ($p<0.001$) gender effect

dwelling elderly, with specific adjustment to the population concerned. By using an address-based register of all nursing homes in the State of Geneva, we could define whether the patient's postal address corresponded to a nursing home or to a private home.

Whether this difference in hip fracture incidence between genders and residential status is due to preventive measures against osteoporosis and falls or to other causes is still hypothetical. During the 10-year study period, prevention strategies and treatments for osteoporosis were increasingly used in Geneva. Since calcium and vitamin D supplementation has been shown to decrease hip fracture incidence in institutionalized women [19, 32] and to be cost-effective in hip fracture prevention in this population [33], a higher level of prescription is likely, especially in patients in nursing homes, who represent almost 40% of the hip fractures in Geneva [17]. Also, we cannot exclude the fact that spontaneous dietary calcium and protein intakes have increased because of widespread publicity in Geneva on the beneficial effects of higher calcium and vitamin D or protein supplementation in elderly with a recent hip fracture [23] or those without [20]. Furthermore, the development of prevention strategies against falls and fracture was increasingly a priority in the State of Geneva over the past decade and may have contributed to a relative lowering of the risk of hip fractures, in particular in people up to 85 years of age. Indeed, preventive programs have also focused on increasing awareness of the risk factors for falls [21], environmental modifications, and promoting physical activity in older people, especially in those living in nursing homes who are two to three times more likely to sustain a hip fracture, even after adjustment for potential confound-

Table 2 Number of hip fractures (*NF*), person-years at risk (*N60+*), mean age at hip fracture (*Age*), incidence of hip fractures per 100,000 person-years, expressed without (*Inc*) and after standardization to the 2000 Geneva population (*IncGE*), over a 10-year period (1991 to 2000), in community-dwelling and institution-dwelling women (≥ 60 years)

	Community-dwelling women					Institution-dwelling women				
Year	NF	N60+	Age	Inc	IncGE	NF	N60+	Age	Inc	IncGE
1991	189	40,059	80.7	472	498	162	2,567	86.2	6,310	6,197
1992	172	40,394	81.3	426	444	145	2,669	86.0	5,433	5,299
1993	176	40,815	81.2	431	435	150	2,732	86.1	5,490	5,498
1994	160	41,249	82.0	388	387	142	2,732	85.4	5,197	5,192
1995	141	41,601	81.0	339	338	132	2,691	87.0	4,905	4,861
1996	183	41,880	81.7	437	440	133	2,693	85.3	4,939	4,908
1997	159	42,185	81.9	377	380	160	2,696	87.0	5,935	5,956
1998	190	42,651	81.8	445	454	138	2,717	86.2	5,079	5,060
1999	200	43,329	82.1	462	463	118	2,619	87.2	4,506	4,549
2000	206	44,033	82.4	468	468	129	2,615	87.4	4,934	4,934
1991–2000	1,776	418,195	81.6	425	431	1,409	26,732	86.4*	5,271*	5,245*

*Significant ($p<0.001$) dwelling effect

Table 3 Number of hip fracture (*NF*), person-years at risk (*N60+*), mean age at hip fracture (*Age*), incidence of hip fracture per 100,000 person-years, expressed without (*Inc*) and after standardization to the 2000 Geneva population (*IncGE*), over a 10-year period (1991 to 2000), in community-dwelling and institution-dwelling men (≥ 60 years)

	Community-dwelling men					Institution-dwelling men				
Year	NF	N60+	Age	Inc	IncGE	NF	N60+	Age	Inc	IncGE
1991	50	27,678	79.0	181	186	22	613	84.3	3,587	3,312
1992	57	28,175	80.8	202	204	21	638	81.3	3,294	3,390
1993	44	28,602	79.7	154	159	20	620	81.9	3,227	3,341
1994	53	29,183	80.9	182	186	17	622	84.5	2,733	2,873
1995	52	29,765	78.7	175	174	21	611	87.3	3,438	3,690
1996	49	30,313	80.2	162	164	21	636	83.8	3,300	3,146
1997	61	30,838	79.1	198	199	26	616	86.1	4,221	4,218
1998	51	31,366	80.4	163	166	24	655	86.4	3,664	3,757
1999	69	31,970	78.6	216	217	22	618	82.7	3,560	3,421
2000	65	32,713	79.7	199	199	21	642	85.7	3,269	3,269
1991–2000	551	300,603	79.7	183	185	215	6,271	84.5*	3,428*	3,442*

*Significant ($p<0.001$) dwelling effect

ing factors [6, 26]. Another possible means of fracture protection in this population is the use of external hip protectors, although evidence of its efficacy is conflicting [34, 35]. The introduction of drugs shown to be effective against osteoporosis [36] and particularly the introduction in 1995 of the bisphosphonate family of medications, which are known to reduce the risk of hip fractures [37, 38] in osteoporotic patients, as well as the setting up of an

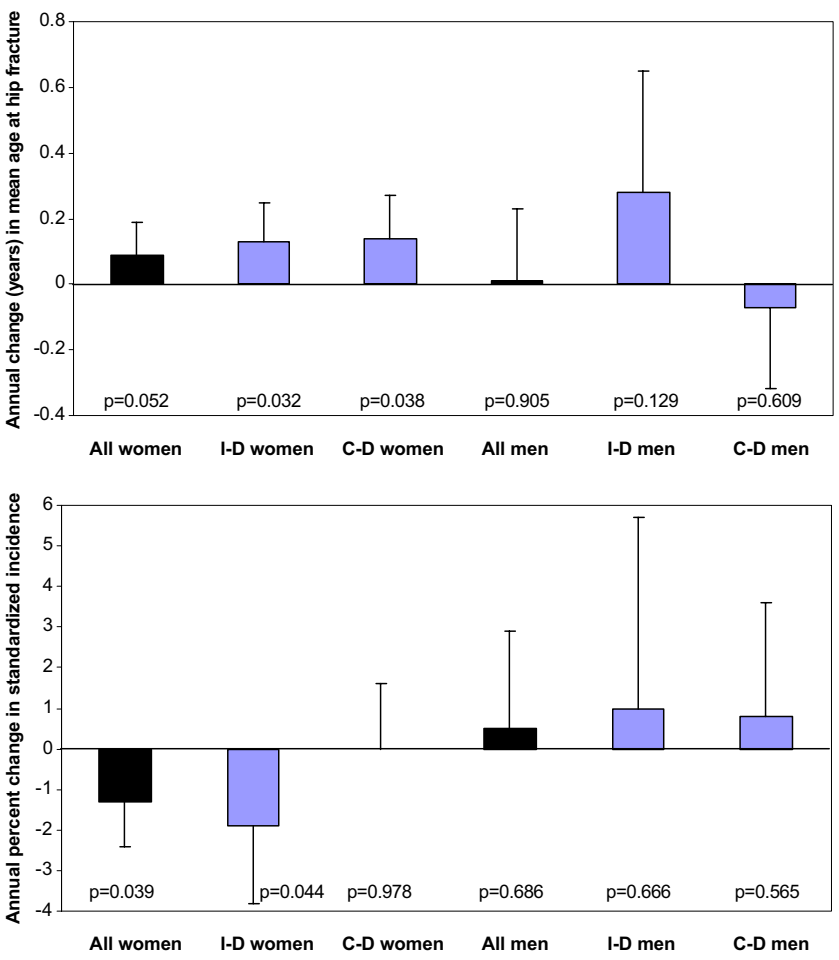

Fig. 2 Estimated annual change (years) in mean age at hip fracture (*upper part*) and annual percentage change in standardized incidence of hip fracture (*bottom part*) over a 10-year period (1991–2000), according to gender and place of residence (institution-dwelling [*I-D*] and community [*C-D*]). The *shaded bars* represent the estimated annual changes and the *thin bars* their 95% confidence interval (the symmetric 95% CI being omitted)

osteoporosis clinical pathway in Geneva [39], may have contributed to this downward trend of hip fracture incidence in women. However, under-usage of antiresorptive pharmacotherapy is common in community-dwelling older adults and in nursing home residents, despite their high osteoporosis prevalence [40]. Nevertheless, it was reported that among those aged 85 and older, nursing home residents were about two times more likely than community-dwellers to receive antiresorptive pharmacotherapy [41]. The fact that the reduction in hip fracture incidence was specifically detectable in institution-dwelling elderly women may suggest that this particular population might have been more exposed to these preventive programs against falls and osteoporosis, as well as to effective drugs against osteoporosis. Since prevalence and awareness of osteoporosis are probably lower in men than in women [42], men could have been less exposed to bone-sparing medication and to preventive measures than women.

Besides those results essential for the reliable estimates of the present and future incidence of hip fractures, this study also confirmed previous results regarding the drastic increase in age- and gender-specific incidence of hip fracture with increasing age. The stabilization of the hip fracture incidence rates previously found in extreme old age was, however, not observed in this study [43]. Incidence was found to be higher in institution-dwelling elderly, who have a higher prevalence of physical disability and mental impairments than community-dwelling elderly [3–7]. In this well-defined catchment area, it was also found, in accordance with recent studies [44, 45], that the mean age at hip fracture increased over time, and that fractures occurred earlier in men than in women. This gender difference is likely linked to the shorter life expectancy among men than among women, considering that the reduction in life expectancy due to hip fracture was found to be similar in both genders [46].

Despite its many strengths, our study has some limitations. First, the register does not allow evaluation of reasons for hip fracture. Nevertheless, a previous study [26] in the same population has shown that fractures due to a fall from standing height, defining thereby osteoporotic origin, occurred in 92% of all patients. Second, during the study period, the total number of community-dwelling women and men of Geneva aged 80 years and over increased more than the total number of institution-dwellers in the same age group. This change in the population age structure over the 10-year study period may then confound the secular trends presented for hip fracture incidence. However, whatever the age classes, the age-specific incidences of hip fractures across the years reveal similar trends toward a secular decrease in hip fracture incidence in institution-dwelling women (data not shown). Therefore, the decrease in standardized incidence among institutionalized women does not seem to be artefactual.

In summary, this prospective 10-year study shows that a reduction occurred in the standardized incidence of hip fracture in women, but not in men. This decrease was mainly due to changes in the standardized incidence of hip fractures in institution-dwelling women. This heterogeneity of trends between sex and residential status is a major finding of our study. In order to better identify the causes responsible for the trend in hip fracture incidence, future analyses of hip fracture incidence should include stratification according to the residential status of the patients with fractures.

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Conflicts of interest None.

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